



Armed Forces College of Medicine AFCM





Pancreatic Secretions **from** **Exocrine part**

By
Mona Gamal El Din Al Anan
Ass. Prof. Physiology



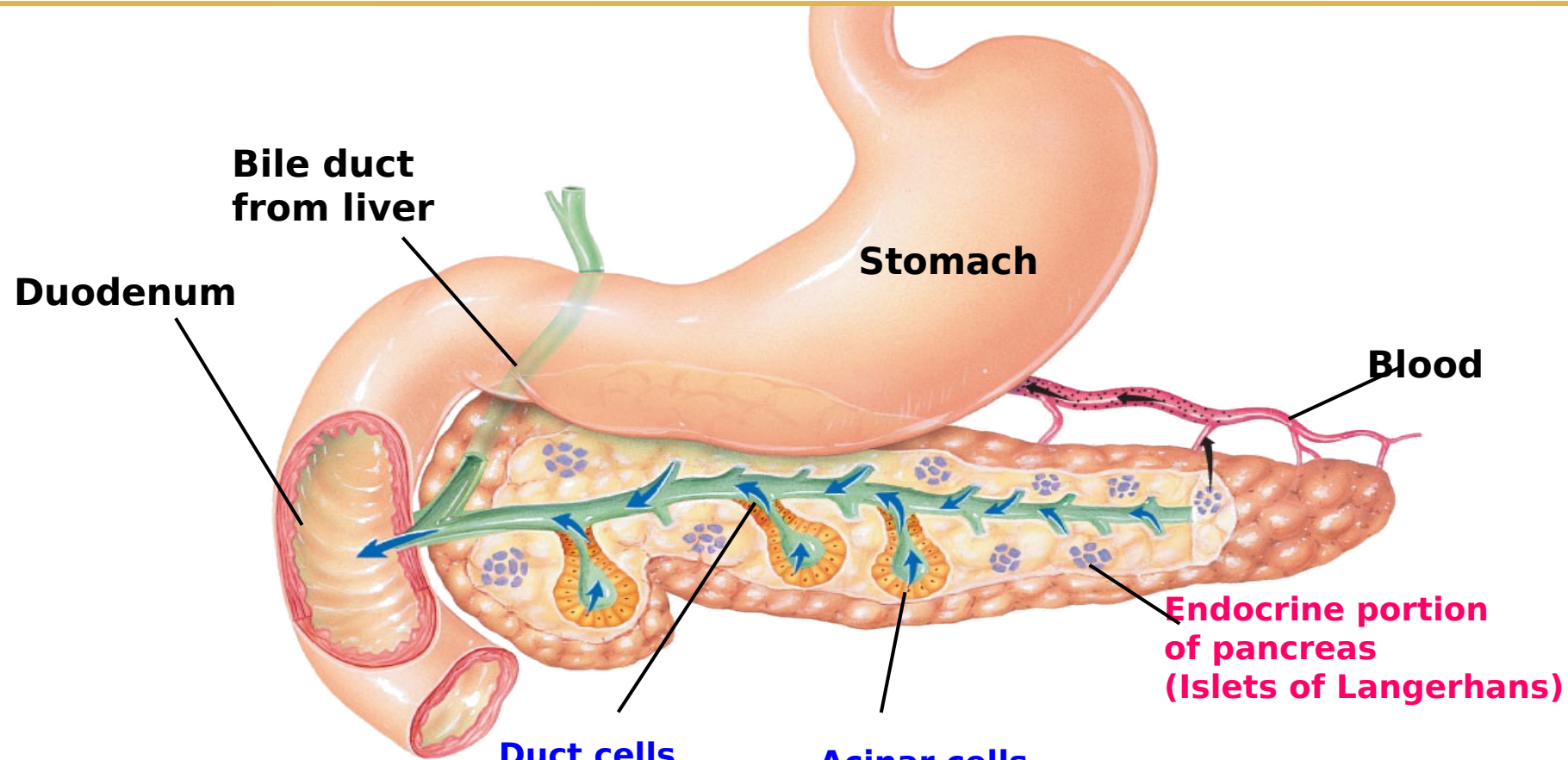


By the end of this lecture the student will be able to:

1. Describe the composition of the exocrine pancreas
2. List the most important pancreatic digestive enzymes
3. Explain their functions in digestion
4. Explain the mechanism by which pancreatic secretion is regulated
5. Apply knowledge to solve clinical problem



The pancreas



Bile duct
from liver

Duodenum

Stomach

Blood

Endocrine portion
of pancreas
(Islets of Langerhans)

Duct cells
secrete
aqueous
 NaHCO_3
solution

Acinar cells
secrete digestive
enzymes

*The pancreas is both
an*

*Exocrine and
Endocrine gland*

Exocrine portion of pancreas
(Acinar and duct cells)

GIT "Pancreatic secretions" Mona Gamal



The pancreas



The pancreas has 2 functions

a) Endocrine function

b) Exocrine function
"Acini are the exocrine secretory units"

Secretes insulin, glucagon,
..... from islets of
Langerhans

Secretion of pancreatic juice
pancreatic duct → Small
Intestine.





The pancreas

“Pancreatic secretion”

Volume

**1-2 L /day
≈ 1500 mL**

pH

≈ 8 (alkaline)

composition

- **Aqueous, alkaline secretion**
- **Enzymes**





The pancreas

“Pancreatic secretion”

Exocrine function of pancreas
It has 2 components

a) Aqueous
component
(contains HCO_3)

b) Enzymatic component

Neutralizing
???

Proper □
Digestion
&

Absorption



Pancreatic secretion



a) Aqueous, alkaline secretion

Secreted by the duct cells

Rich in HCO_3^-

HCO_3^- content (approximately 113 mEq/L vs. 24 mEq/L in plasma)

Neutralize acidic chyme in duodenum

Protect Duodenal Mucosa

↑ Efficiency of Pancreatic enzymes
Provides optimum medium for action of pancreatic enzymes.

N.B.: Bile and intestinal juices are also neutral or alkaline, and these three secretions neutralize the gastric acid, raising the pH of the duodenal contents to 6.0 - 7.0



Pancreatic secretion

b) Pancreatic enzymes



Proteolytic enzymes
Digest protein

Actively secreted by acinar cells

Pancreatic amylase
Digests carbohydrate

Pancreatic lipase, Prothrombinase,, ...
Digest fat

Pancreatic nucleases
Hydrolyze RNA & DNA



Composition of Pancreatic secretion



Composition of pancreatic secretion

Water 99.5%

Solids 0.5%

Organic substances

Inorganic substances

Enzymes

Other organic substances

Proteolytic enzymes

1. Trypsin
2. Chymotrypsin
3. Carboxypeptidases
4. Nucleases
5. Elastase
6. Collagenase

Amylolytic enzymes

1. Pancreatic amylase

Lipolytic enzymes

1. Pancreatic lipase
2. Cholesterol ester hydrolase
3. Phospholipase A
4. Phospholipase B
5. Colipase
6. Bile-salt-activated lipase

1. Albumin
2. Globulin

1. Sodium
2. Calcium
3. Potassium
4. Magnesium
5. Bicarbonate
6. Chloride
7. Phosphate
8. Sulfate



Digestive enzymes of pancreatic juice



Source	Enzyme	Activator	Substrate	Catalytic Function or Products
Exocrine pancreas				



Digestive enzymes of pancreatic juice



Source	Enzyme	Activator	Substrate	Catalytic Function or Products
Exocrine Pancreas (Cont.,)				

Digestive enzymes of pancreatic juice



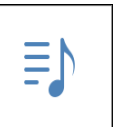
pancreatic proteolytic enzymes

Secreted in an inactive form

Activated in duodenal lumen

So, pancreas protect itself from digestion by proteolytic enzymes.

How?



Protection of the pancreas from autodigestion



1 Polypeptidolytic enzymes remain inactive until they reach duodenum

2 Pancreas

Secretes

Trypsin inhibitor

Inhibit

Trypsin

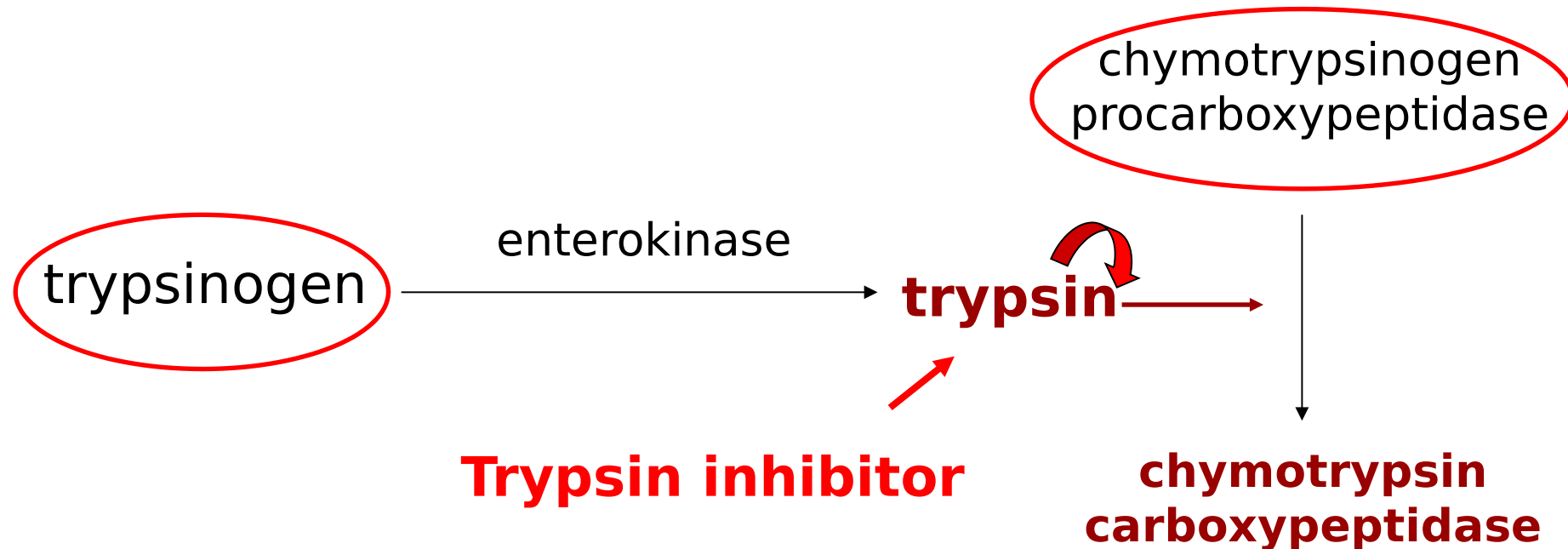
N.B.: Trypsin is responsible for activation of all other enzymes



Protection of the pancreas from autodigestion



Inhibition of pancreatic autodigestion



Failure

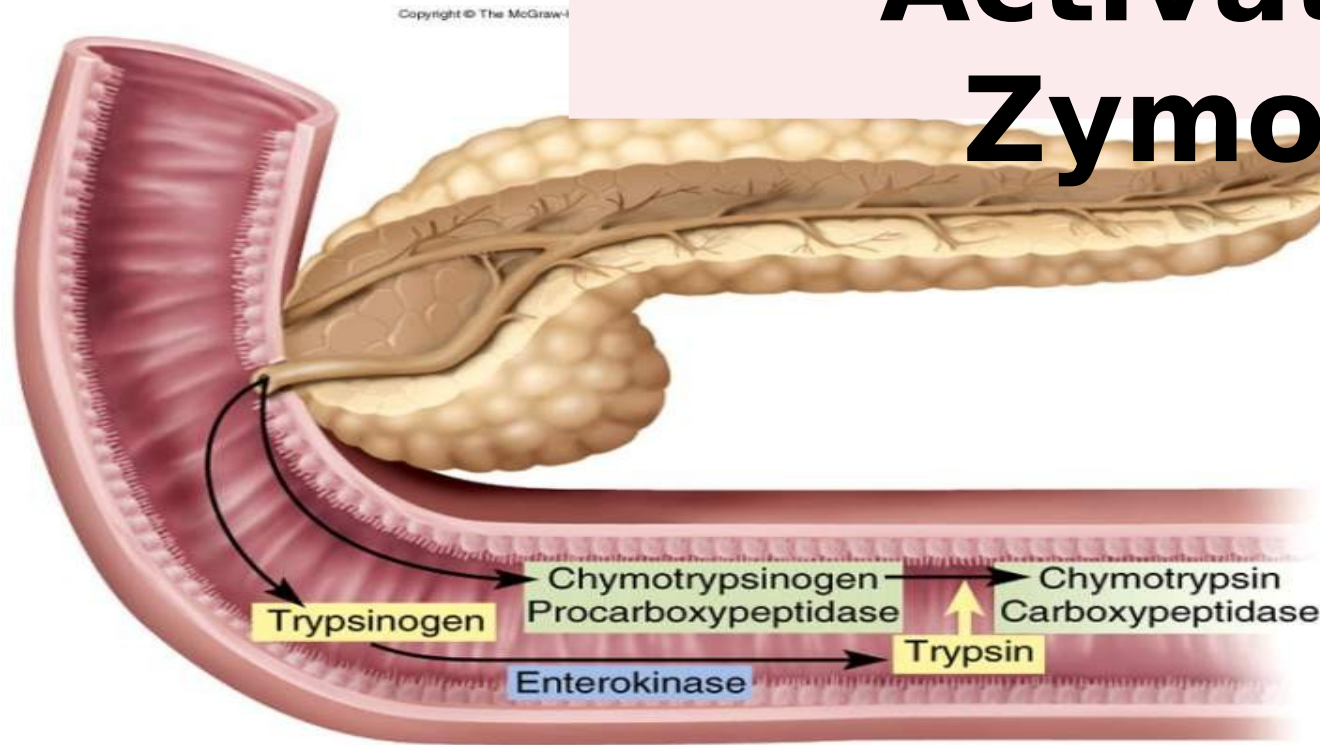


PANCREATITIS





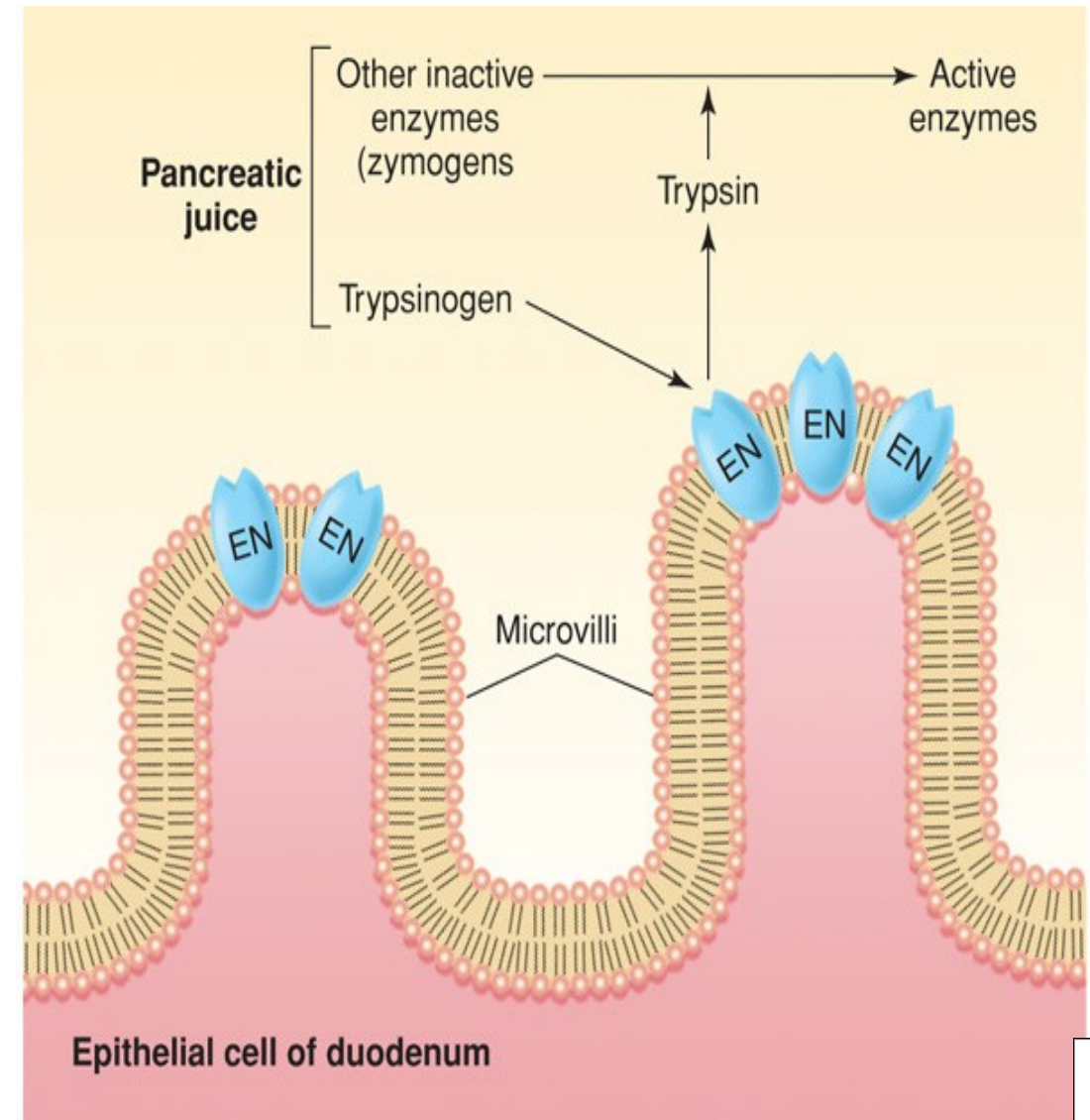
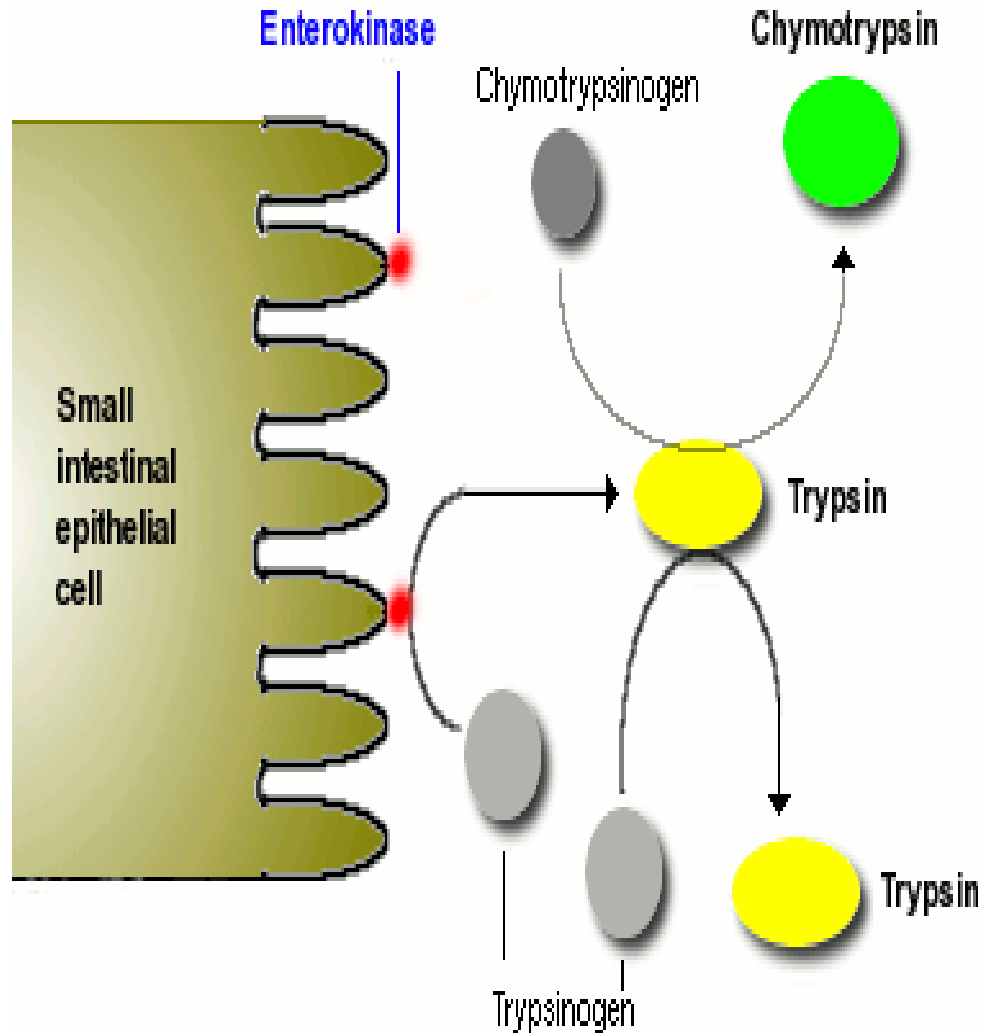
Activation of Zymogens



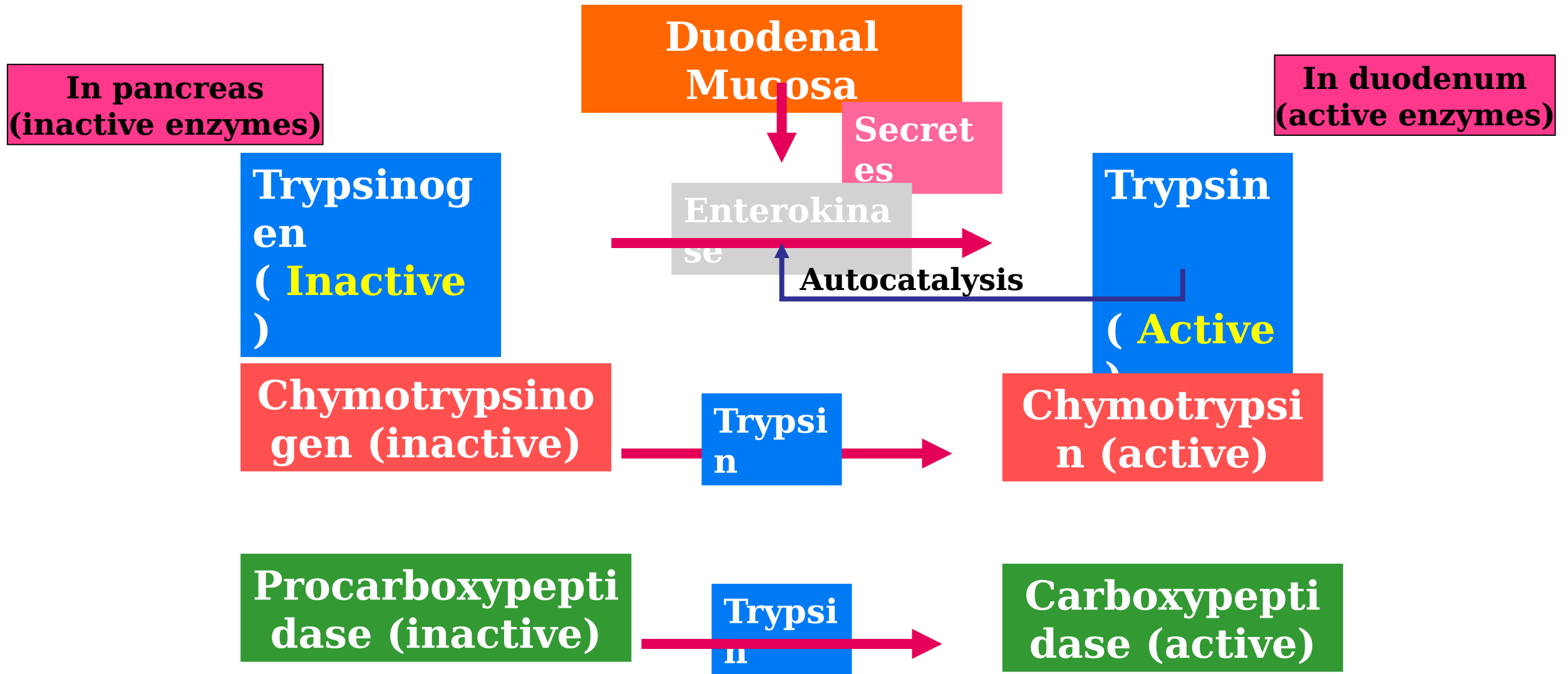
- Most pancreatic enzymes produced in an inactive form (zymogens)
- Trypsinogen converted to trypsin by enterokinase (brush border enzyme).
- Trypsin activates many other zymogens (also digests dietary protein) to their



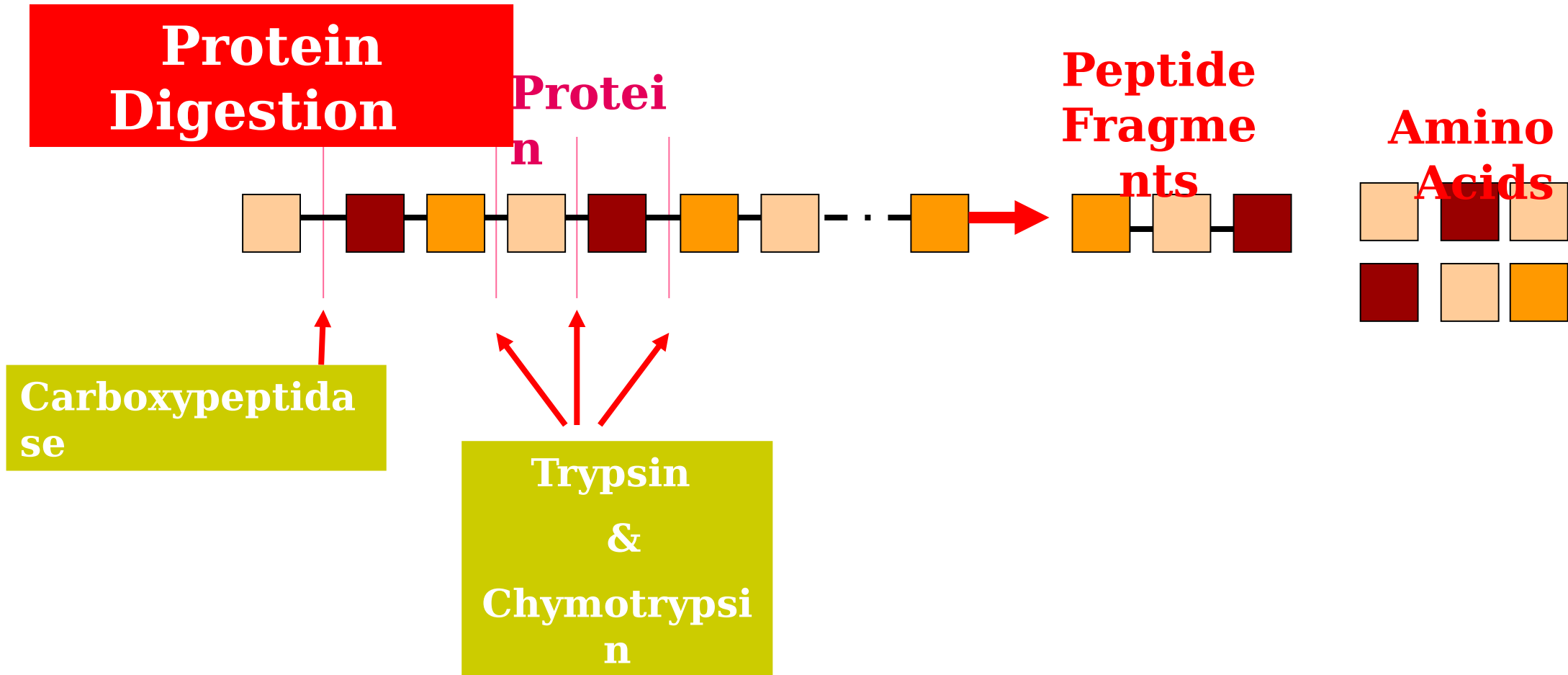
Protection of the pancreas from autodigestion



Mechanism of enzymes activation

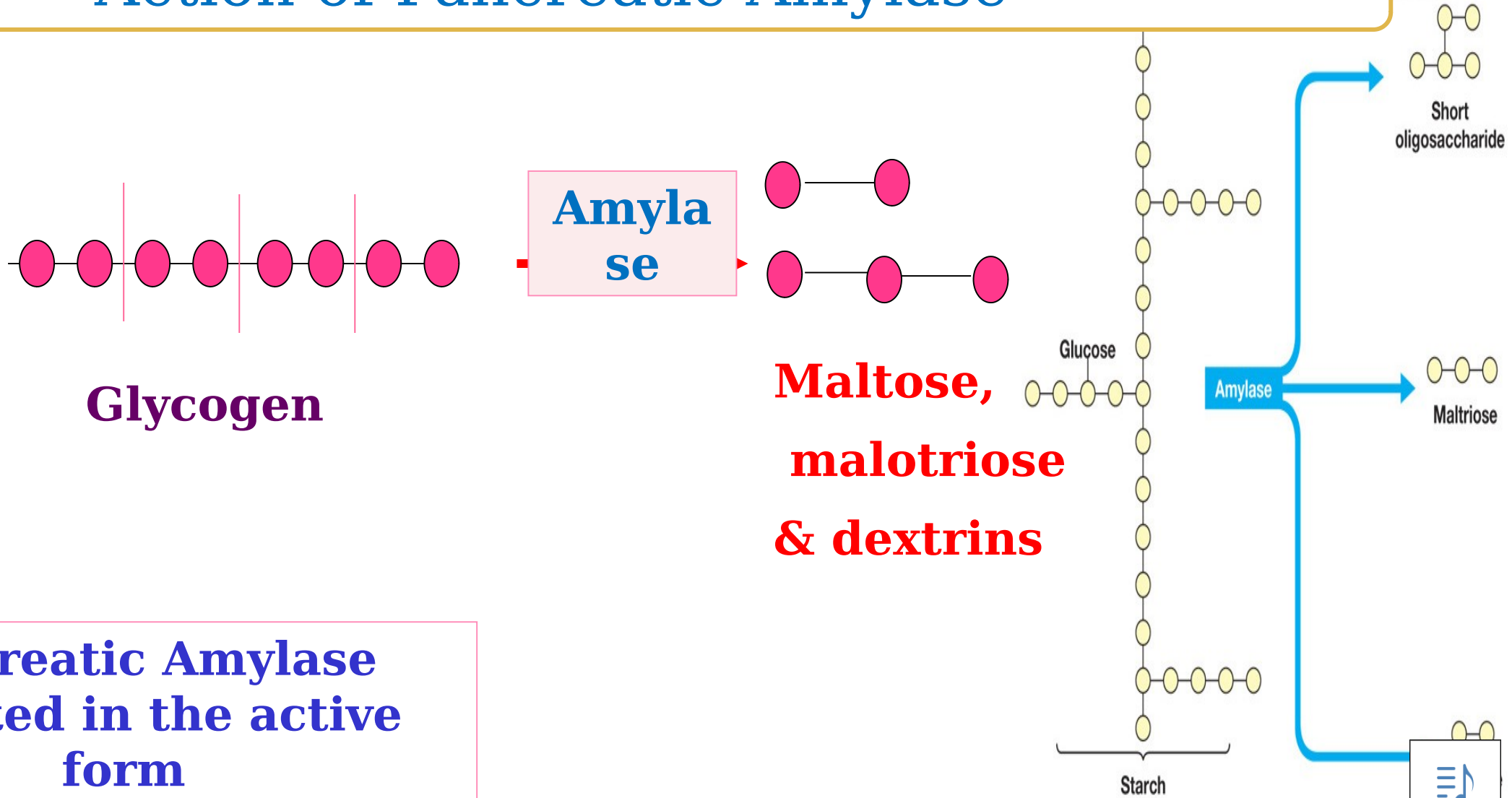


Protein digestion



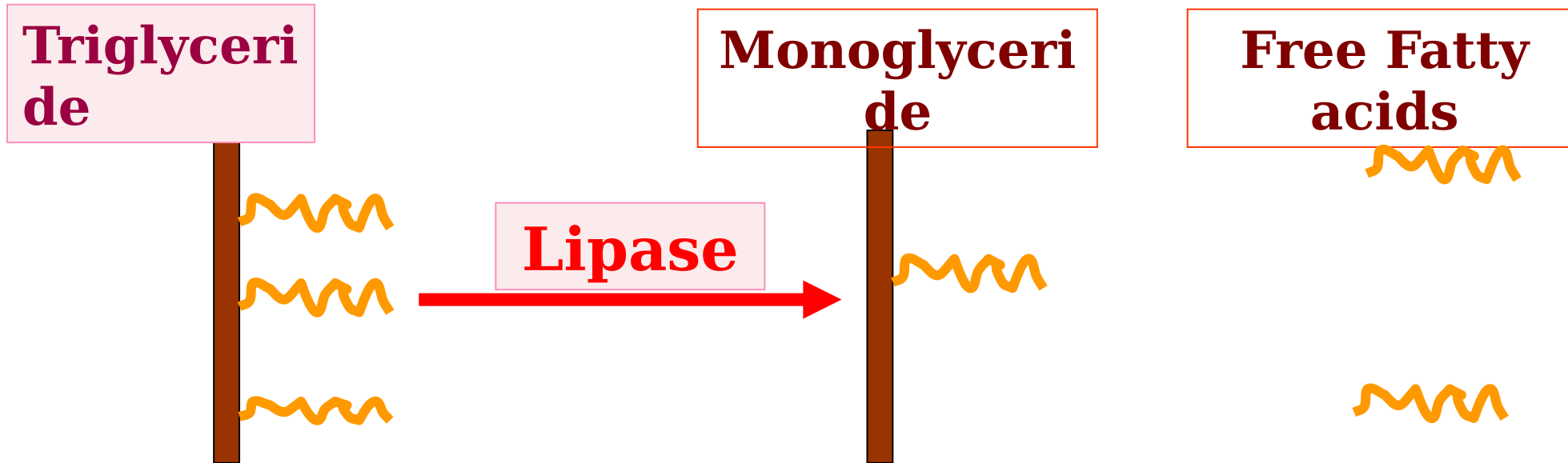
Carbohydrate digestion

“Action of Pancreatic Amylase”



**Pancreatic Amylase
secreted in the active
form**

Fat digestion



Pancreatic lipase secreted in its active form

Other pancreatic lipolytic enzymes include cholesterol ester hydrolase, phospholipase A₂, ..., colipase and bile salt

activated lipase.

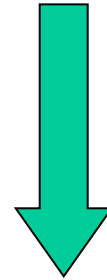




**Deficiency of pancreatic
enzymes**



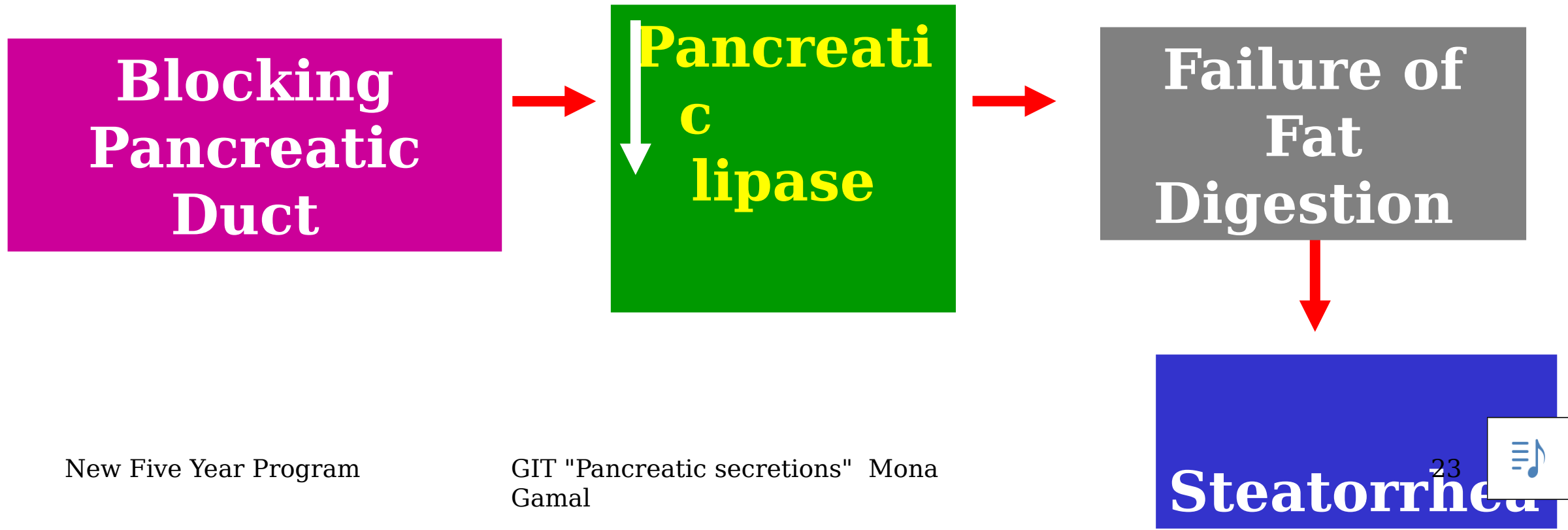
Steatorrhea



**Excessive
Undigested Fat in
Feces**



Fat digestion





Steatorrhea

Failure of Fat
Digestion &
Absorption



Failure of Absorption
of Fat Soluble
vitamins e.g.
Vitamin D



**Vitamin D
Deficiency**



**Intestinal
absorption of
Ca⁺⁺**



Blood Ca⁺⁺

Vitamin A

New Five Year Program

Deficiency ??

Vitamin K

GIT "Pancreatic secretions" Mona Gamal

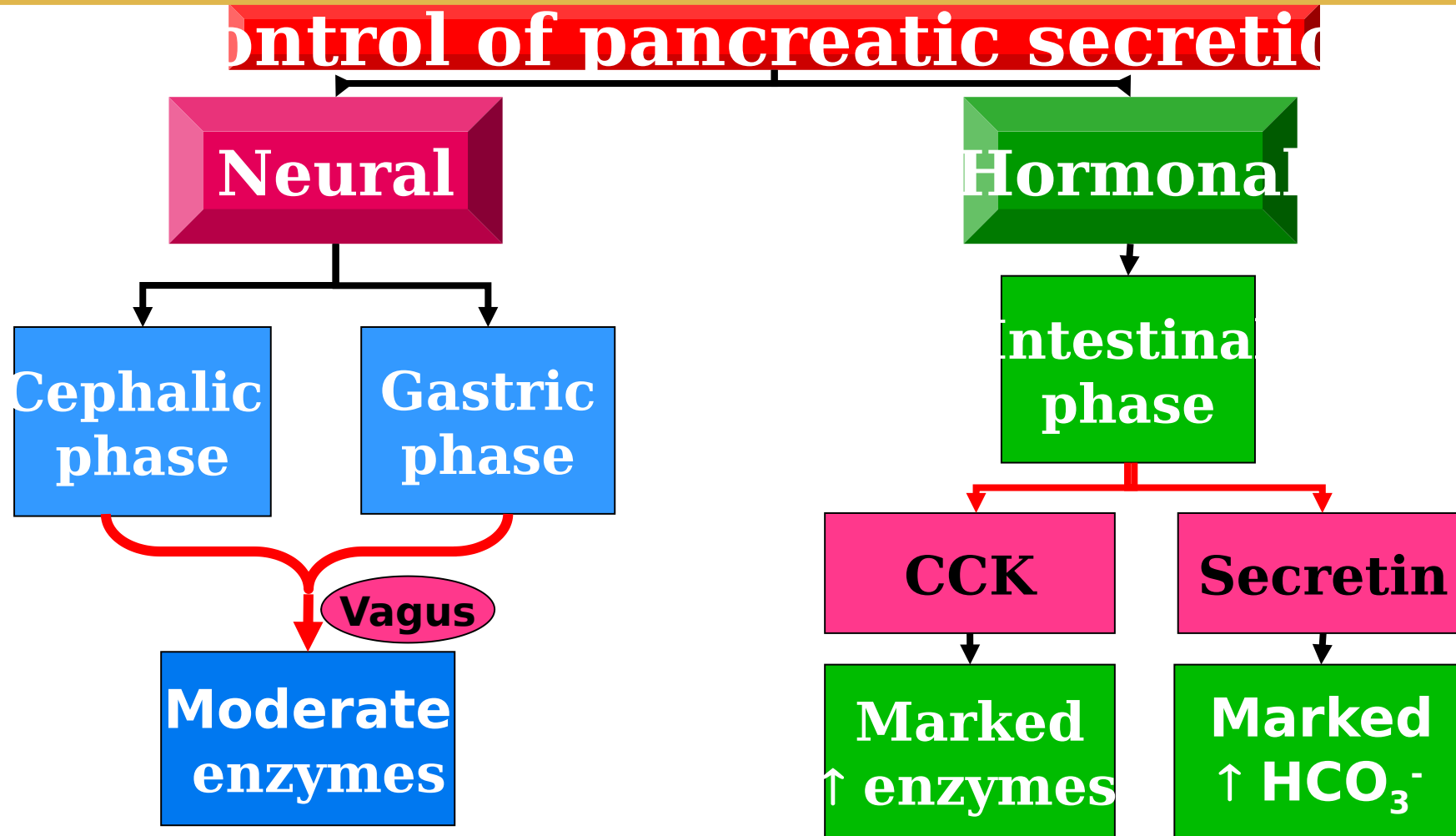
Deficiency ??

Vitamin E

deficiency ??



Discuss the digestive enzymes of pancreatic juice



Neural control of Pancreatic secretion ??? %



Cephalic phase (weak effect)

**Both conditioned &
unconditioned Reflexes**

**Thinking ,
Sight or
Smell of
Food
Food in
Mouth
(chewing)**

**(+)
Vagus**

**Salivary
Secretion**

**Gastric
Secretion**

**Pancreatic
Secretion**

**Liver
Secretion**

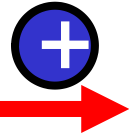


Neural control of Pancreatic secretion



During gastric phase (weak effect)

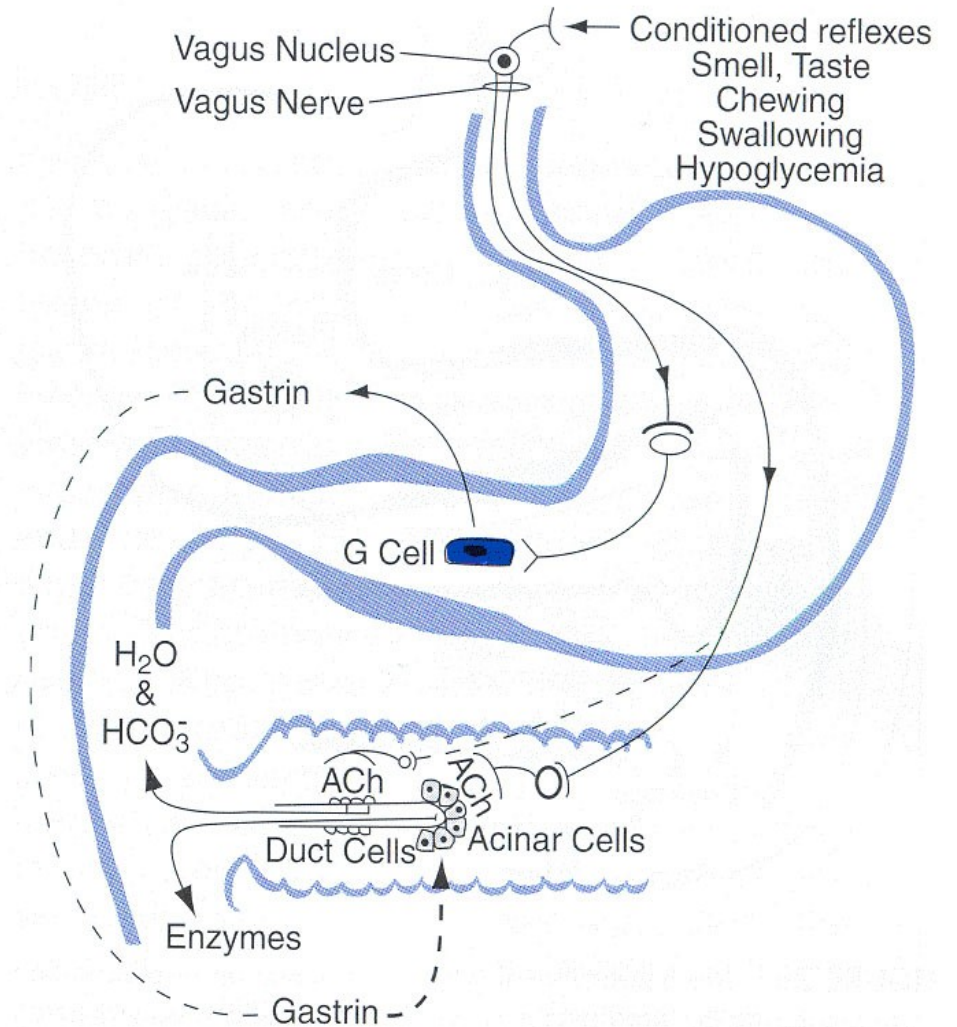
Food in stomach



Pyloric gland area

Gastrin Secretion

Stimulate pancreatic secretion



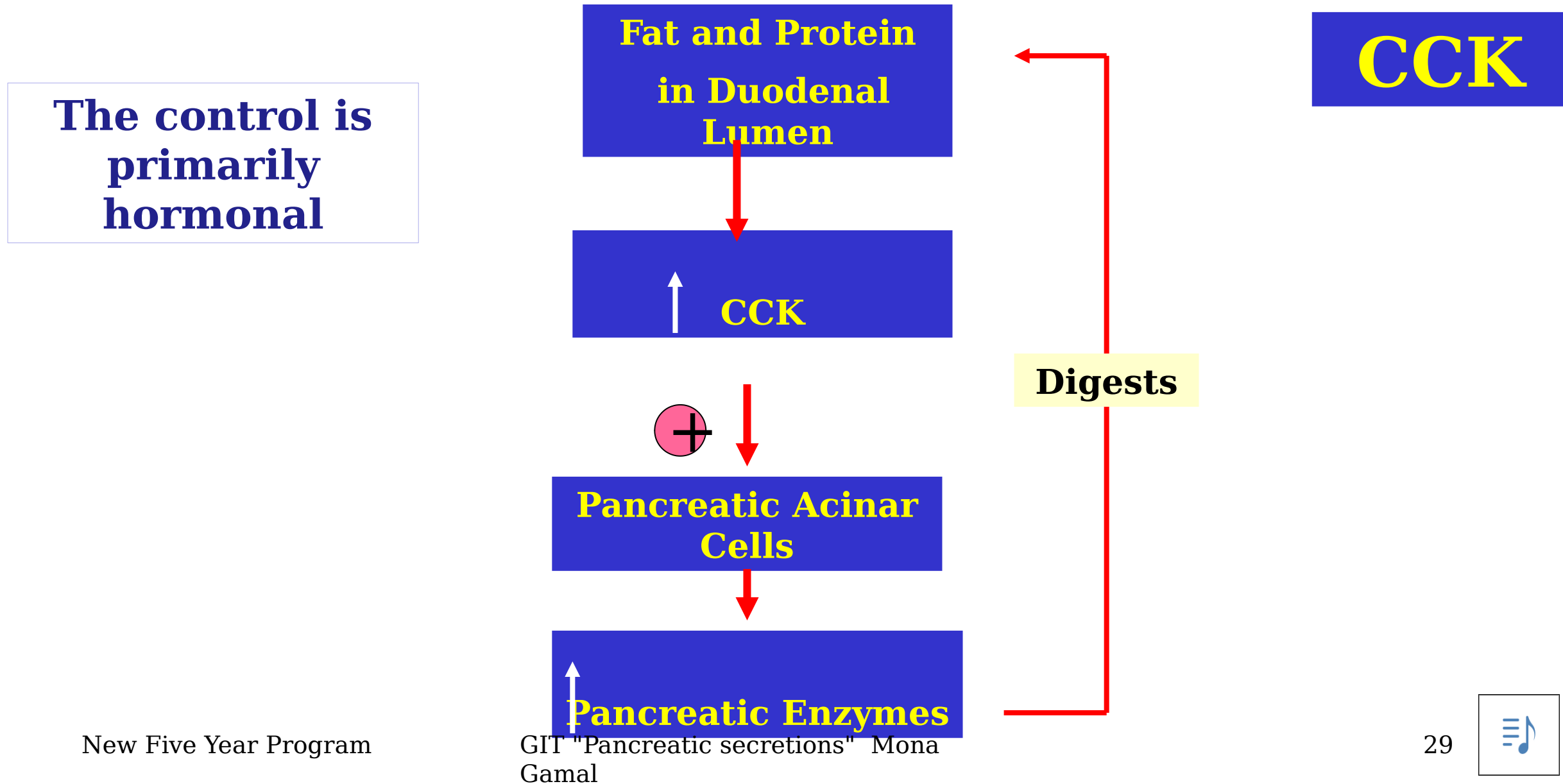
??????????????



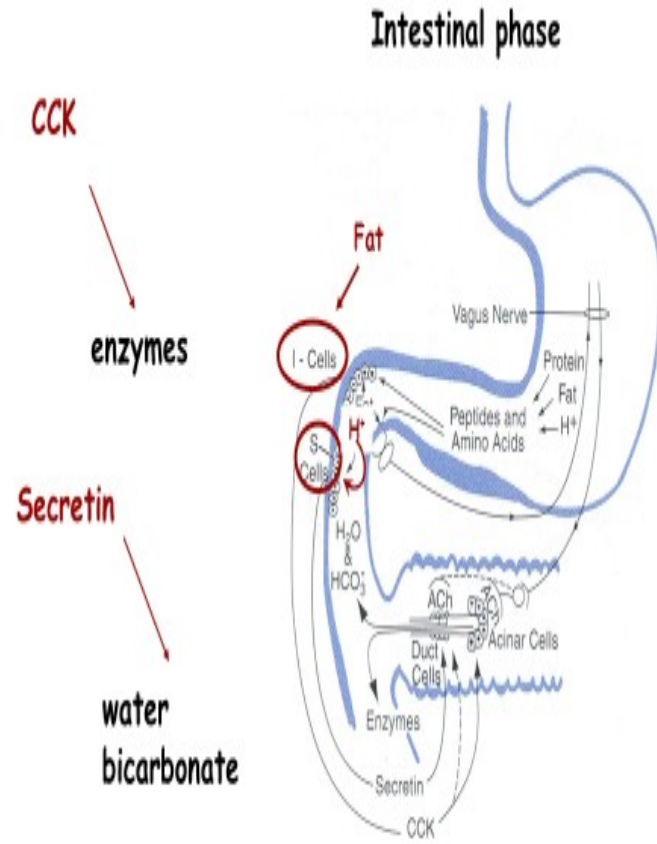
Hormonal control of Pancreatic secretion “ %”



The control is primarily hormonal



Hormonal control of Pancreatic secretion “ %”



**Acid
in Duodenal
Lumen**

**↑
SECRETIN**

+
Pancreatic Duct Cells

**↑
Aqueous NaHCO₃
Solution**

Secretin

Neutralizes

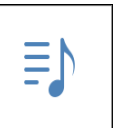
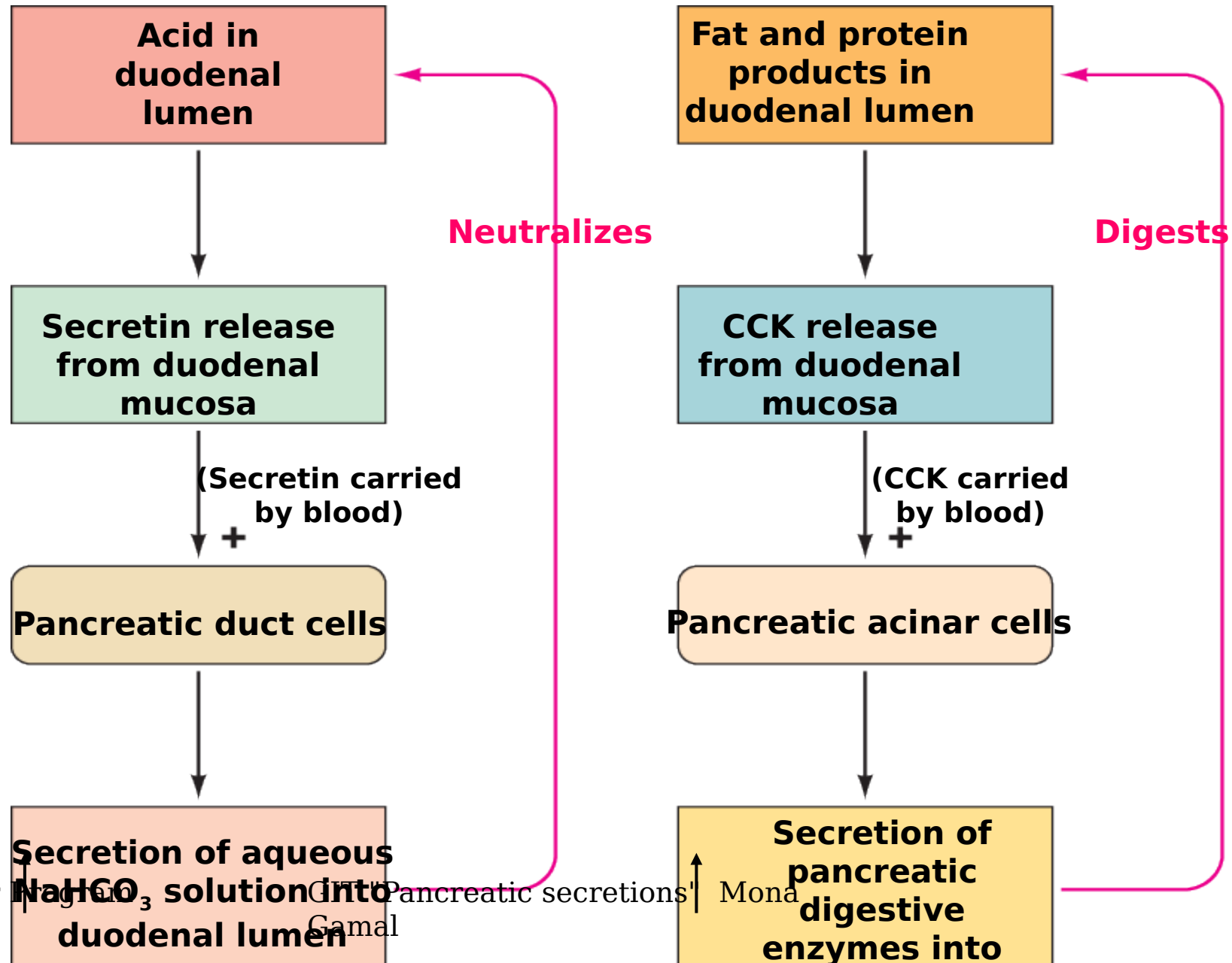
**The control is primarily
hormonal**

New Five Year Program

GIT "Pancreatic secretions" Mona
Gamal

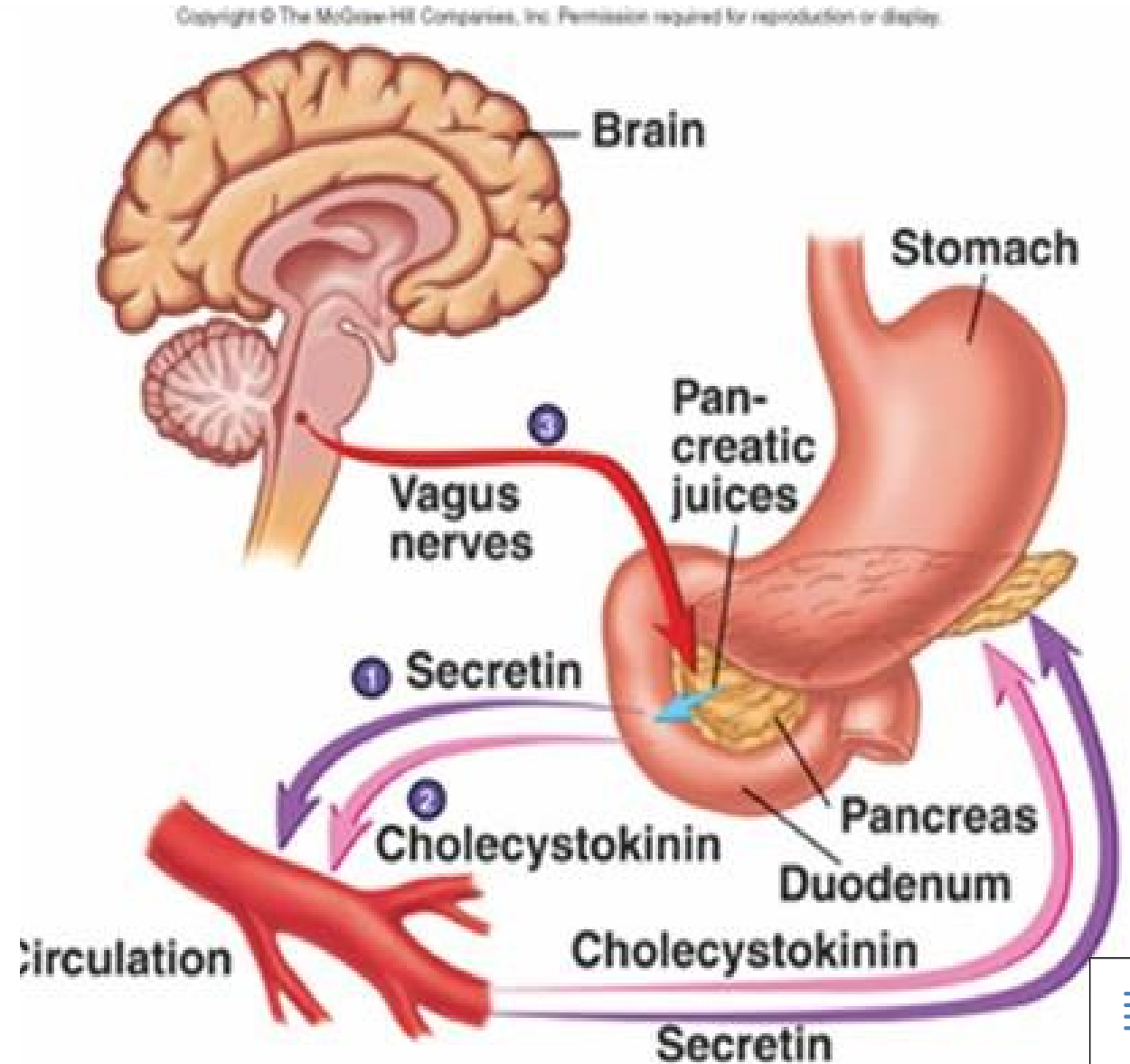
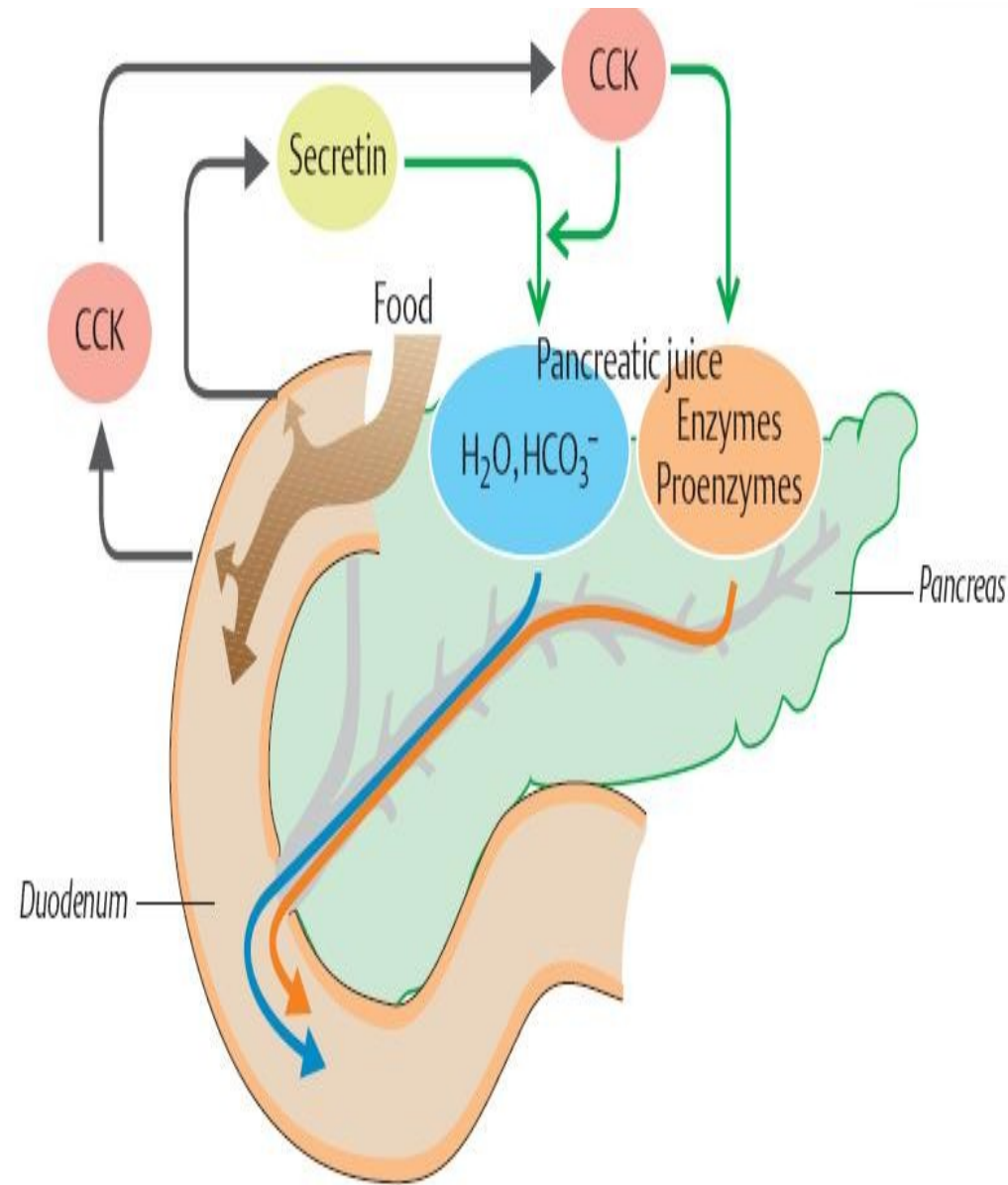


Control of Pancreatic secretion “ + ”



Describe the different mechanisms for control of pancreatic secretion

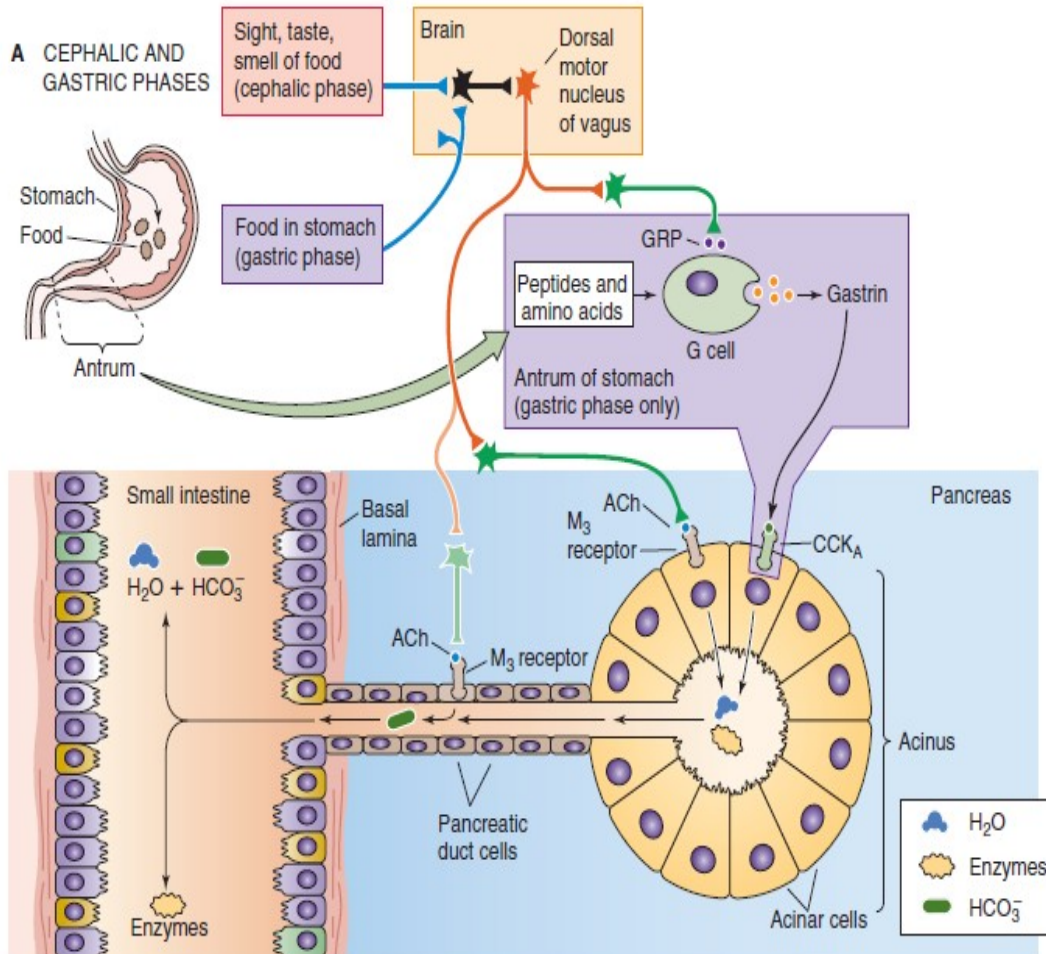
Summary for Regulation of Pancreatic secretion



Summary for Regulation of Pancreatic secretion

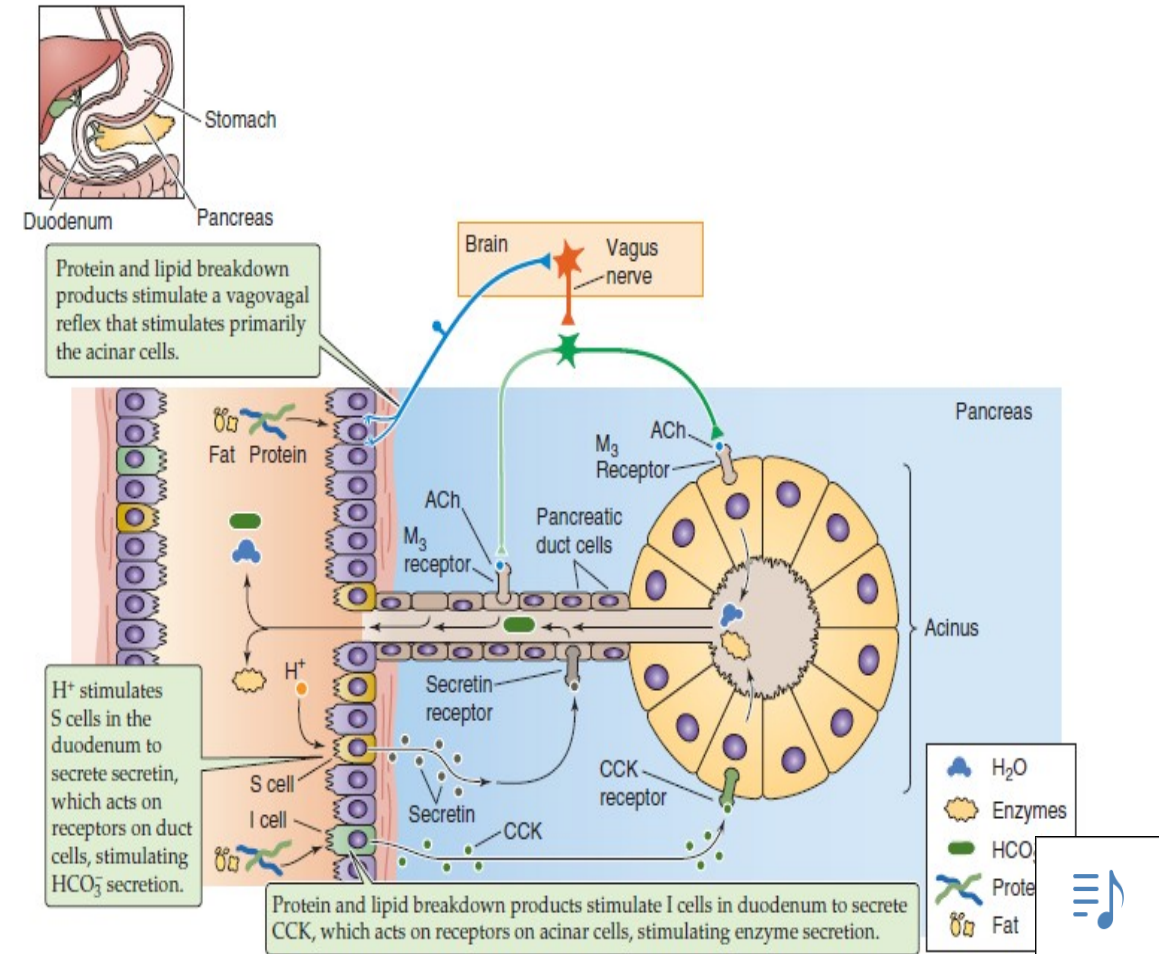


Cephalic and gastric phase of pancreatic secretions



Intestinal phase of pancreatic secretions

B INTESTINAL PHASE





Regarding pancreatic secretion:

- a) Pancreatic secretion is inhibited by gastrin secreted by the G cells of the antrum
- b) Pancreatic acinar cells contain trypsin
- c) Cholecystokinin inhibits secretion from the exocrine pancreas
- d) The introduction of acid into the duodenum stimulates pancreatic secretion





Regarding pancreatic secretion:

- a) Pancreatic secretion is inhibited by gastrin secreted by the G cells of the antrum
- b) Pancreatic acinar cells contain trypsin
- c) Cholecystokinin inhibits secretion from the exocrine pancreas
- d) The introduction of acid into the duodenum stimulates pancreatic secretion



SUGGESTED TEXTBOOKS



1. Ganong's "Review of Medical Physiology", 25th edition,
Section V gastrointestinal physiology, Chapter 26
2. Guyton and Hall "Textbook of Medical Physiology", 13th
edition, Chapter 64, Secretory Functions of the Alimentary
Tract
3. Sembulingam "Essentials of Medical Physiology", 5th
edition, Chapter 41

